(on the foregoing assumption) be accounted for by supposing that the cloud-bands are very near the surface, so near that the light reflected therefrom has to pass through a thickness and density of atmosphere comparable in its effects to that above the more uninterrupted parts of the surface.

Further observations may obviate the necessity for this or any other more feasible explanation, by proving that the band is mainly due to the earth; but, as before shown, the weight of evidence, Mr. Huggins's observation taken into account, is in favour of the assumption that the line, as seen on Jupiter at considerable altitude, is mainly due to the planet itself.

The general appearance of the spectroscopic image is one of nearly uniform brightness, with the marked exception of the brighter band P Q, and the much darker band Q R: in this band the principal absorption takes place at the more refrangible end of the spectrum, where it is very considerable, gradually diminishing, but yet conspicuous, up to E; at moments it may be traced very faintly up to D, with no certainty beyond.

In this band Q, R are not separable; considering the size of the image this can hardly be due entirely to closeness, but would seem to show that (at the more refrangible end at least) the absorption of the yellow and somewhat dark space enclosed between Q, R is little inferior to that of Q, R themselves. P is not conspicuous, but is unmistakably seen in good moments as a narrow streak at the blue end.

The experiment was made of placing the slit parallel to the planet's equator; when in this position and moved slowly over the surface, or arrested at particular points, no peculiarity was distinguishable; so little do the parts differ in brightness, that by this method it could not, from the mere evidence of the spectrum, be told what part was being admitted through the slit; in this method, however, greater delicacy of adjustment is required, for slight want of parallelism of the slit to the bands brings in disturbing effects.

The edges of the disk were examined, but without result.

Observatory, Melbourne, December 5, 1869.

III. "On the Nebulæ of Argo and Orion, and on the Spectrum of Jupiter." By A. Le Sueur. Communicated by Prof. G. G. Stokes, Sec. R.S. Received February 21, 1870.

Among the following observations made with the great Melbourne telescope, the most important are those of η Argo; the spectrum of this star is crossed by *bright lines*.

The mere fact of a bright-line spectrum is not very difficult to ascertain on a good night; for although from faintness of the light the phenomenon is necessarily delicate, yet the bright lines occasionally flash out so sharply that the character of the spectrum cannot be mistaken. The most marked

lines I make out to be, if not coincident with, very near to C, D, *b*, F, and the principal green nitrogen line. There are possibly other lines, but those mentioned are the only ones manageable.

Direct spark comparison has hitherto been found impossible; though plainly marked at moments the lines require concentrated attention, and will not permit the disturbing effect of other light in the field; attempts were made to diminish the brilliancy of the spark spectrum but with no good result, a different method was therefore adopted.

By watching for good moments the pointer was placed on a particular star line, the spark spectrum was then turned on, and the position of the pointer noted.

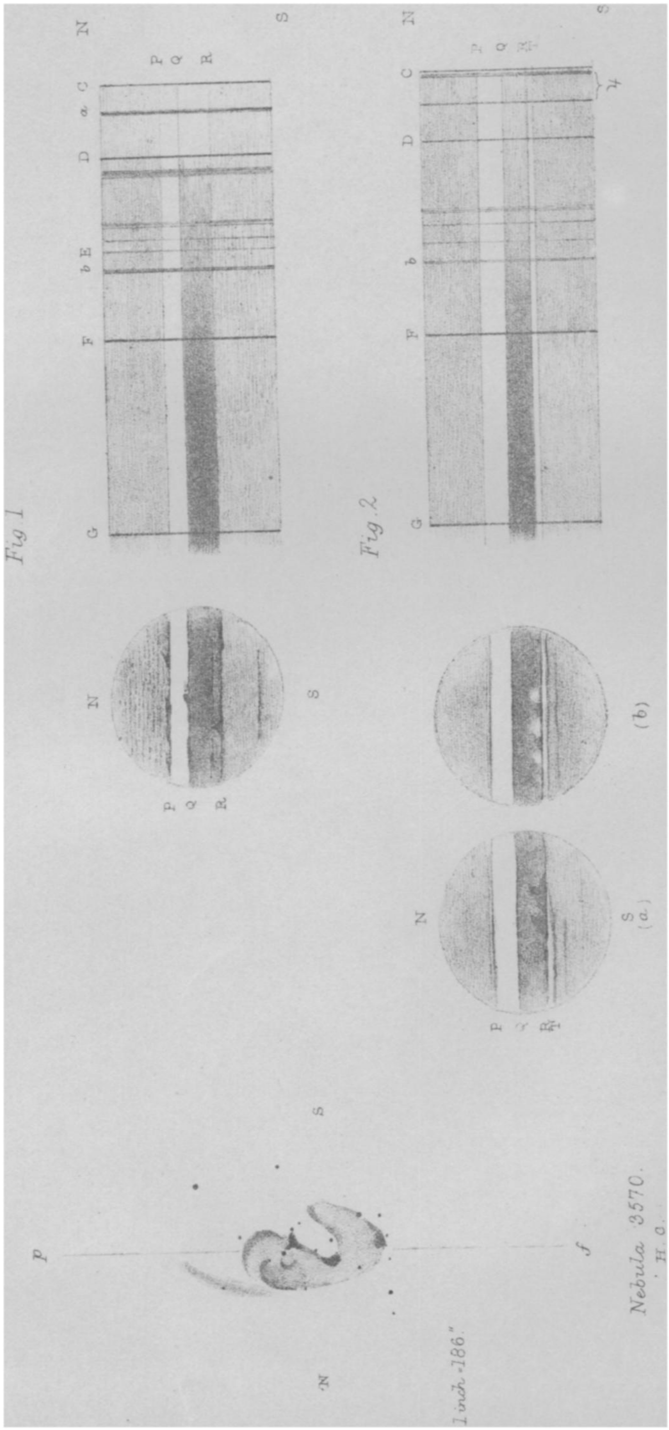
By this means it was seen in repeated trials that star lines within the limits of the dispersion used (about 7°) were coincident with C, F, the principal green nitrogen line, and *b*, or rather (the spark employed was platinum in air) the air-band involved in *b* group. It cannot be determined whether the coincidence is with the magnesium group or the air-band; nothing more definite can be said than that the star line lies within the limits of the group.

The comparison spectrum employed does not show F, but the position of the previously adjusted pointer, with reference to air lines in the neighbourhood, leaves little doubt as to the identity of the blue star line with F, due regard being had to the collateral evidence (when such close limits are reached) that C coincides with a red star line. The yellow (or orange?) line in the star has not yet received sufficient attention; it is, however, very near D.

With the dispersion employed, D and the bright air line on less refrangible side of D are well separated; so that, notwithstanding the delicacy of the star line, I hope, if not to get satisfactory evidence of coincidence with a particular line, at least to eliminate one of the competitors; at present it cannot even be said whether the line may not be slightly more refrangible than D; the limits are, however, very small, placing the bright air group about 1180 of Mr. Huggins's scale completely outside the possible range.

I would remark that the very faint nebulosity (if any) in the immediate neighbourhood of the star η is incompetent to give a trace of spectral lines with even a wide slit; for a considerable space s. and f. of η no lines are at all visible; the nearest nebula bright enough to show a line (the three usual lines are now easily seen on a good night over the brighter parts) is reached in the direction about 45° n. p. from η, and even then the distance from η, as judged by the appearance in the spectroscope with η threaded on the thus directed slit, is little less than one minute. This remark is of some importance in connexion with the ordinary telescopic observations of the nebula, but is mentioned at this point to relieve any impression which might arise that the nitrogen line seen on the star spectrum is merely the chief nebula line crossing it.

Le Sueur.



W. H. Wesley lith.

W. West imp.

In the present state of the inquiry there is little doubt left as to the presence of hydrogen in the star; the other lines may perhaps be accounted for by nitrogen alone, or by nitrogen, magnesium, and sodium.

On the whole the weight of collateral evidence will probably be considered to be in favour of the latter combination, with the possibility that for sodium may have to be substituted the substance which produces the line in sun-protuberance spectrum.

For although there is no direct evidence as to identity of the line near D, if the coincidence were with the orange nitrogen line it would be reasonable to expect a line in the star corresponding to the yellow line 1180+, yet none has been made out in that position; again, the second green line has probably less claims for visibility than the orange or yellow lines, yet in the star spectrum this line is not less well seen than that coinciding with the chief nitrogen line. These considerations, though perhaps not entitled to great weight, at least lead in the direction of the above inference.

Owing to faintness of the general spectrum no dark lines are made out; one in the red is strongly suspected, and occasionally there is an appearance as if of a multitude over the spectrum generally, but they refuse to be seen separately and certainly.

It is fortunate that these observations have been possible in the present magnitude of the star; may not the bright-line character of the spectrum be due to a commencement of increase? The star has not perceptibly changed since I knew it.

I extract the following estimation from the Melbourne observations:—

		Mag.	
1863.	Oct. 14.....	5	
1864.	May 6	4·5	
„	„ 19.....	4·5	The estimations are by Mr. White, who has charge of the Transit Circle. Mr. Ellery estimated it last year as a $6\frac{1}{2}+$, and now thinks it is somewhat brighter.
1865.	„ 22.....	4·5	
„	June 14	4·5	
1868.	April 21	4	
„	May 27.....	4	
„	„ 26.....	5	
1869.	„ 2	$6\frac{1}{2}$	
„	„ 11.....	$6\frac{1}{2}$	
„	„ 30.....	6	

At an earlier stage of the observations with the Melbourne reflector, I was on the whole inclined to think that the difference between the view of the nebula about η Argo as seen with the 4-feet reflector, and that seen by Sir J. Herschel with his 18-inch, though strongly marked in the neighbourhood of η, was yet, due regard being had to aperture and other disturbing causes, capable of being accounted for without going to the length of assuming such enormous changes as would result if the sketches represented the true facts in both cases. It was thought that the presence of the star η might have a large disturbing effect, increased by aperture, and that therefore an erroneous impression might be formed of the confi-

guration and character of the nebula in its proximate neighbourhood. (The trapezium of Orion, as will be seen from observations to be presently recorded, is a case in point.)

The spectroscope has, however, decided that η in no way influences the configuration as now seen; the star is not only apparently but really on a background, if not completely dark, at least free from nebulosity at all comparable to the brighter parts; moreover the nebulosity at s. end of lemniscate (the shape there is occasionally made out, showing that nebula does exist) is of a similar faint character.

With this evidence that the eye-view with the 4-feet approaches the actual facts, and a due consideration of those facts, it seems difficult to imagine any conditions of aperture, definition, or other disturbing causes which could produce a view at all approaching to that seen by Sir John Herschel.

We have therefore evidence of much weight that enormous changes have taken place in this wonderful region. Is not the presence of nitrogen and hydrogen in the star η a significant fact in connexion with these changes, which appear to be nothing less than a destruction of nebula specially in its neighbourhood?

Orion has been examined with a new and interesting result; the spectroscope proves that in and about the trapezium nebula exists comparable with the bright surrounding nebula.

This observation is rendered easy by the large separation of the stars consequent on great focal length of telescope; indeed the whole separation of the original image is not required, the observation being made more crucial by a condension of between two and three times; with this arrangement the separation is still sufficient, and the advantage is gained of viewing at the same time the bright surrounding nebula.

The stars, sharply focused to give a linear spectrum, being threaded on the slit singly or in pairs, or cautiously removed out of the field, it is seen that the bright lines cross the trapezium with little if at all diminished brilliancy.

The ordinary telescopic view is therefore an erroneous one, produced by the disturbing effect of the bright group.

Jupiter has been examined (generally on moonlight nights); with this object the orginal Cassegrain image is too faint for good work, but by interposition of a suitable lens the image is condensed at pleasure within certain limits; with the light thus increased the Fraunhofer lines G, F, *b*, E, D are always easily seen, C also easily on a clear night; the lines to which special attention has been directed are the telluric lines 914 and 838 (for convenience of reference I use throughout the numbers in Mr. Huggins's

Jupiter and sky diagram). These are the only lines seen with certainty between C and D.

The identity of 914 and 838 rests partly on measures and partly on spark comparison, where, for the identification of 914, it is seen that this line is near to the air band 807 of Mr. Huggins's chemical scale.

The line 914 is so easily seen, that having in mind Mr. Huggins's statement concerning the difficulty of discerning it at all, originally very imperfect measures on a bad night and with the apparatus imperfectly adjusted misleading in the same direction, this line was at first mistaken for 882, from which, however, it is separated far beyond the limit of error in a proper state of adjustment of apparatus.

882 is not seen at all with Jupiter at considerable altitude. On the night of December 29th, however, between the hours of 12.30 and 1, Jupiter being low, 882 was seen almost as conspicuous as 914, which, I may remark, did not seem to have perceptibly increased in darkness by the additional absorption of the earth's atmosphere.

On the night of December 14th (both objects being near the meridian) the spectroscope was turned on Jupiter and the moon alternately several times. On Jupiter 914 and 838 were easily visible, the former (as usual) the more conspicuous; on the moon no line could be certainly made out between C and D. Mr. Ellery was present at the time and gave the same verdict.

So far these observations are merely confirmatory of those made by Mr. Huggins. There is one point, however, not unworthy of consideration, arising from a comparison of the observations in connexion with the conditions under which they are made.

It is probable that Mr. Huggins, with his earlier apparatus, was under more favourable conditions as regards light than, if not the best at my command, at least those under which 914 is now plainly seen. When condensed as much as arrangements allow (about four times), I probably get a somewhat brighter image at the slit than that produced by Mr. Huggins's telescope; but with little or no condensation, and a dispersion of near 7° (B to H=6° 50′), the line in question is still conspicuous. Yet Mr. Huggins speaks of this line as barely distinguishable, or not at all visible with his earlier apparatus. Width of slit, of course, plays a prominent part; but I cannot be wrong in assuming that, for prospecting purposes, Mr. Huggins tried various widths. Moreover when the slit is gradually cut down, 914 is visible as long as the chief Fraunhofer lines, and is still readily seen when the light is insufficient to show a trace of C or 838 near it.

These considerations, if not entitled to much weight, at least point to a possible variability of the line in question. If this prove to be the case, it will be interesting to note its degree of visibility in connexion with the character of the surface at the different times of observation.

I cannot find whether 914 or 838 is involved in the lines proved by M.

Jansen as special to aqueous vapour. An answer one way or the other would be equally interesting; for Mr. Huggins's observations and my own later ones (which are indeed merely corroborative) go far to prove that, whatever the cause of the lines, that which produces 914 and 838 has on Jupiter more efficacy than that which produces 882, while the reverse appears to be the case on the earth.

Jupiter was taken in hand specially to note any peculiarity in the spectrum of different parts of the surface, as regards general or specific absorption. The best observations were made on the night of December 11th, when the phenomena were as given in the diagram (Plate I. fig. 2), to which the second figure of Jupiter is added merely for any additional interest to be derived from two views on the same night (*a* at 9.30, *b* at $11.30\pm$).

The space N P is slightly yellowish, and appears at good defining moments to be crossed by a multitude of fine hair lines (this has been seen more than once); P Q is white, and considerably brighter than the general surface; Q R dusky yellow, much darker than N P; R T white; T S similar to P Q, but more approaching to white.

P, Q, R, T dark brown with occasional suspicion of green tinge.

The spectrum, as given in the diagram, is an inversion (to suit telescopic image of planet) of what is seen in the spectroscope with the slit perpendicular to Jupiter's equator.

The absorption of Q, R is most marked beyond F, fading gradually away to about E; beyond this Q, R are seen separately with an apparently undiminished spectrum between them; P Q is much brighter than the general spectrum, and is normal throughout; T R occasionally flashes out brightly; P stretches equally across the spectrum; T is most marked at the less refrangible end (the reverse of this was the case for one of the belts on a former occasion).

A special point aimed at in these observations was to note any peculiarity in the lines 914, 838 as they cross the various parts of the surface in this position of the slit, but no satisfactory evidence could be elicited. As before mentioned, by the interposition of a suitable lens the image, still focused on the slit, may be condensed at pleasure within certain limits; a point is therefore chosen at which the compromise between brilliancy of spectrum and size of image is deemed most suitable for the object in view. The light is quite adequate for the purpose when the bands T Q, Q R are still of considerable width; any difference, if not very slight, in the line 914 as it crossed the different bands ought therefore to have been detected. This was not the case. The experiment was tried of placing the slit parallel to the bands, but with no new result.

Melbourne Observatory, January 3, 1870.